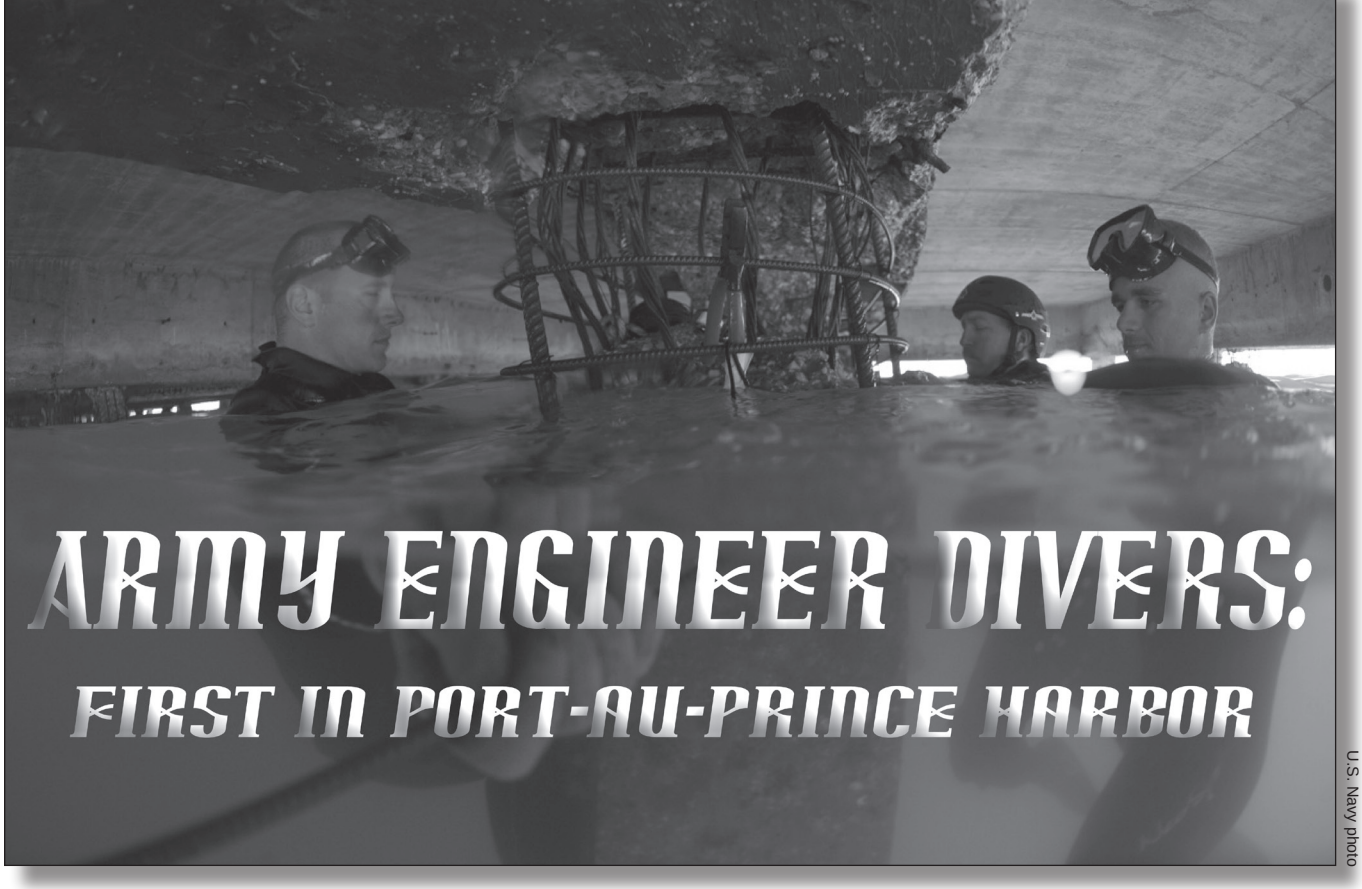

ARMY ENGINEER DIVERS:
FIRST IN PORT-AU-PRINCE HARBOR

U.S. Navy photo

By Captain Scott Sann, Captain Jerry M. Hallman, and Dr. David J. Ulbrich

A massive earthquake measuring 7.0 on the moment magnitude scale shook Port-au-Prince in Haiti on 12 January 2010. Physical damage and loss of life reached cataclysmic proportions, with at least 200,000 Haitians dead, 250,000 injured, 500,000 homeless, and 300,000 buildings destroyed or condemned. The quake also closed Baie de Port-au-Prince and ruined its main pier and quay, leaving large sections submerged or damaged and severely degrading the ability to offload desperately needed supplies (Figure 1, page 8).

On the same day, the United States Army 544th Engineer Dive Team was aboard the auxiliary rescue and salvage United States Naval Ship (USNS) *Grasp* (T-ARS-51) on a training exercise with Belizean and Guatemalan forces in South America. Shortly after the quake hit, United States Southern Command (SOUTHCOM) diverted the USNS *Grasp* and the 544th to Port-au-Prince. Once there, the Army divers' tasks were to assess the damage to harbor facilities and then attempt to reopen the port for incoming humanitarian relief. The 544th was the first dive element to arrive on the scene in Operation Unified Response—the U.S. military's response to the earthquake. The unit came under the control of Combined Task Group 42.1, as part of Joint Task Force Haiti. This article tells the Army engineer divers' story from 18 January to 31 March, and it analyzes the lessons learned from what would become one of the most ambitious dive operations in recent Army history.

In addition to helping assure mobility of troops and equipment, and according to Field Manual 3-34.280, *Engineer Diving Operations*, "Engineers provide support to general engineering operations in and around the water." To accomplish the latter mission in Haiti, 544th divers performed many key tasks subsequently listed in the manual: hydrographic surveying, planning, inspecting, clearing, repairing, constructing, rehabilitating, and opening ports.

Phases of Operation

Efforts of the 544th could be divided into three distinct phases during 10 weeks of Operation Unified Response. Phase I entailed making assessments of damage to several harbor facilities. Phase II included more complex assessments, as well as preparing the pier for rehabilitation, delegating tasks, and creating timelines. In Phase III, the Army divers worked jointly with United States Navy elements to repair the pier's piles and thus rehabilitate the pier. Throughout all three phases, Army divers used a wide spectrum of surveying, salvage, and construction capabilities, while Navy divers brought specific knowledge about particular aspects of salvage and construction operations. The Army divers initially worked with the Navy's Mobile Diving and Salvage Unit 2 (MDSU 2) and later with the Navy's Underwater Construction Team 1 (UCT 1).

Phase I: Level I Assessment (18 to 23 January)

After taking on extra supplies at Guantanamo Bay on 15 January, the USNS *Grasp* debarked for Port-au-Prince, arriving on the morning of 18 January. Everyone in the 544th realized the seriousness of the situation after seeing a Haitian corpse floating in the ocean about 10 miles from

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14. ABSTRACT
A massive earthquake measuring 7.0 on the moment magnitude scale shook Port-au-Prince in Haiti on .12 January 2010. Physical damage and loss of life reached cataclysmic proportions, with at least 200,000 Haitians dead, 250,000 injured, 500,000 homeless, and 300,000 buildings destroyed or condemned. The quake also closed Baie de Port-au-Prince and ruined its main pier and quay, leaving large sections submerged or damaged and severely degrading the ability to offload desperately needed supplies

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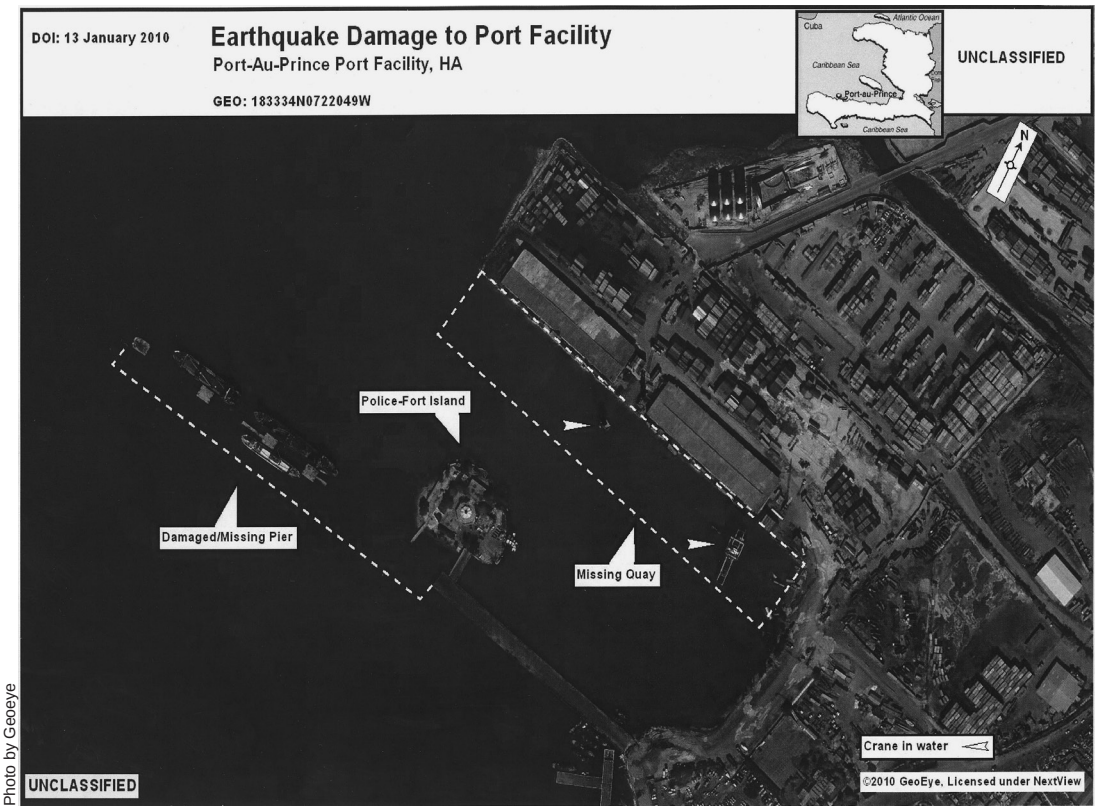


Figure 1. Satellite image of Haiti's Port-au-Prince harbor

the harbor. It was then that Army divers realized they were the first responders to this natural disaster.

Once anchored in the harbor, the 544th found no existing infrastructure and no command and control (C2) node. Without waiting for C2 to be established, the divers started conducting triage-style Level 1 Assessments of all affected port facilities. They made visual inspections and photographed the north quay wall and the south pier. They logged several hours of "bottom time"—time from when a diver leaves the surface of the water until he begins ascent back to the surface. Their inspections of the piles and bents supporting the southern pier revealed extensive damage. Concurrently with the Level 1 Assessment, they made hydrographic surveys to determine the harbor's contour lines of depth (using sonar) and location (using the Global Positioning System [GPS]).

MDSU 2 divers worked to locate submerged hazards north of the pier. Thereafter, the Navy's fleet survey team marked off clear channels with buoys to aid that landing craft, utility/landing craft mechanized (LCU/LCM) in offloading of supplies—albeit in relatively small amounts—directly onto the beach as part of joint logistics over-the-shore (JLOTS) operations.

The 544th divers submitted their Level 1 Assessment to the Naval Facilities Engineering Command (NAVFAC) engineer for analysis and guidance regarding subsequent activities. The 50-foot-wide by 1,000-foot-long north quay wall was damaged beyond repair, because so much of that wall crumbled or collapsed into the water. Although a 400-foot-long span of the south pier completely disintegrated during the earthquake without possibility of reconstruction, the south pier's 800-foot span remained standing and could be rehabilitated. No substantive repairs, however, could begin until salvage equipment and an underwater hydraulic tool package arrived from the 544th's home post of Fort Eustis, Virginia.

Early in the morning of 20 January, the first of several setbacks occurred when a 6.1 tremor hit Port-au-Prince. This caused divers to postpone repairs to the southern pier until the aftershock's effects were known. The NAVFAC engineer and the divers conducted a reassessment and found that the tremor caused no significant damage. Meanwhile, UCT 1 helped coordinate reception, staging, onward movement, and integration (RSOI) because additional equipment and personnel arrived in the harbor every day.

Phase II: Level 2 Assessment and Preparations (24 to 30 January)

On 24 January, the completion of Combined Task Group 42.1's laydown area in the Port-au-Prince main terminal established a C2 node for the entire operation. Beginning that same day, Army divers made a Level 2 Assessment, which more comprehensively surveyed the structural integrity of the pier. They also consulted with the NAVFAC engineers on how best to strengthen the 800 feet of the south pier still above water. No less than 39 bents (each with 6 piles) needed either minor repairs or complete replacement. The pier was supported by several dozen bents reaching along the length of the pier to the harbor floor.

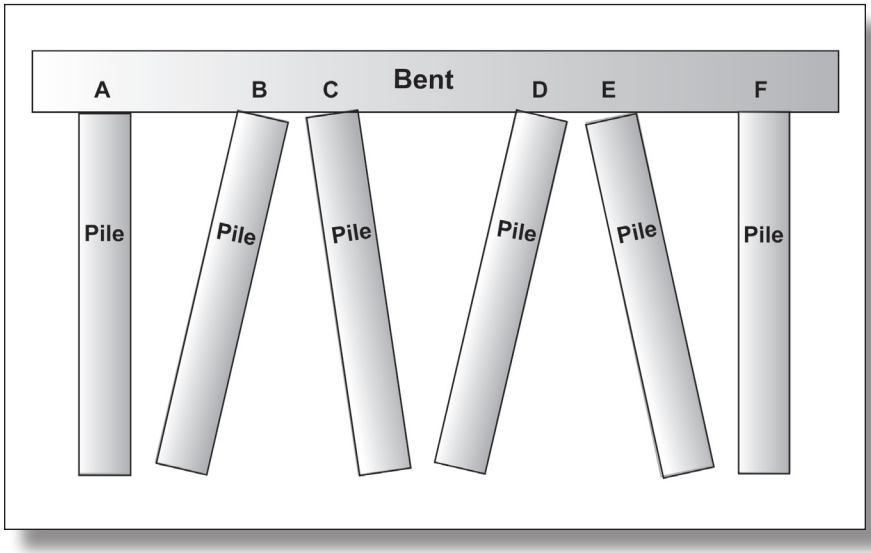


Figure 2. Diagram of bent/piles before earthquake

Each of these bents consisted of 6 piles in a row across the width of the pier. The 2 outermost piles stood vertically at 90-degree angles, while the 4 inner piles alternated at steep angles (Figure 2).

Throughout Phase II, divers from UCT 1 and the 544th painted marks on the top side of the south pier, identifying the degree of damage and the corresponding repairs. The Army divers then used hammers and chisels to clear marine life and loose materials from the south pier's piles. Though tedious, cleaning all 234 piles (of the 39 bents) took several divers only 2 or 3 days. The preparatory work would ensure that pile caps could be added quickly when the Phase III started.

On many days, the divers encountered a serious problem—poor visibility, sometimes as low as 2 feet—due to the debris and filth in the water. Limited visibility was one of several environmental challenges for the 544th, who experienced some of the worst imaginable diving conditions in Port-au-Prince harbor. Petroleum floated on top of the water, and numerous marine hazards like jellyfish, human waste, and debris floated beneath the surface. Adding to the perilous conditions, crews on Haitian tugboats routinely discharged their septic tanks into the harbor. Brown clouds of refuse could be seen moving from the tugboats under the pier to where the Army and Navy divers were working. Making the situation more dangerous, the high water temperatures caused heat casualties among the divers.

Phase III: Repairs and Rehabilitation (31 January and 27 March)

With the assessments and other shaping actions completed, the 544th spent part of 31 January resting and part of it determining the composition of dive teams, while prioritizing tasks to streamline work flow. Some piles retained partial structural contact with the pier above, and thus small gaps could be easily and quickly reinforced by filling them with grout spread by divers using hand trowels. However, most piles in most bents were sheared completely away from the pier above, requiring complete reconstruction to the upper portions of the piles (see photo below). Rehabilitation work on the south pier began on 1 February and lasted for the next 7 weeks. A multistep process developed over time, in which the 17 Army and 7 Navy divers worked together closely and effectively.

Once repairs began, divers of the 544th, wearing wet suits and masks, drilled about a dozen vertical holes for the 2 outermost vertical piles and another dozen diagonal holes for the 4 inner piles on each bent. They drilled holes for 3 bents (18 piles) per day, so the entire drilling operation took about 2 weeks. This exhausting task required 2 divers for each 45-pound hydraulic drill, alternating their drilling every few minutes into the pier above. Other divers in scuba gear remained nearby to retrieve any

U.S. Navy photo

Divers found many severely damaged piles like this one.

U.S. Navy photo

This prefabricated wooden form was emplaced around a rebar cage at the top of damaged piles to hold concrete until it cured. This created the pile caps reinforcing the structure.

dropped tools in the 20-foot-deep water, to assist if any accidents occurred, and to emplace friction clamps on which the divers stood while operating the drills.

Once holes were drilled, another set of divers injected epoxy into the holes and inserted 6-gauge rebar, which extended downward and overlapped with the tops of the piles below. Next, the divers wrapped 3-gauge rebar horizontally around the vertical rebar to create a cage that would give strength to the pile once the concrete was poured. This step was completed in a few minutes for each pile. Last, a prefabricated wooden form was emplaced around each cage on the piles, and concrete was pumped into the form. After 24 hours, the concrete had sufficiently cured, connecting the new pile to the cap above. The wooden form could then be removed and used again on other piles and bents. The process of pumping the concrete was by far the most time-consuming, because it required half a workday for each bent.

Meanwhile, divers operating the drills moved on to the next bents and began the incremental process again—as long as the equipment continued to function and the weather continued to be favorable. The 544th and UCT 1 divers continued drilling holes, emplacing rebar, attaching forms, pumping concrete, and removing forms for all the severely damaged bents. The last bent was completed on 24 March after about 7 weeks of work. At that time, NAVFAC engineers evaluated the structural strength of the south pier, and they determined its load capacity to be 500 pounds per square foot, as opposed to the pre-earthquake load capacity of 750 pounds per square foot. On 27 March, when the south pier was fully able to receive offloaded humanitarian supplies along its 800-foot span, the 544th Engineer Dive Team secured its equipment and departed for Fort Eustis.

Problems Faced—Solutions Found

As the 544th's situation report for 9 February states, "Good rhythm [was] established on the dive side between UCT and Army crews; pace should start picking up now that concrete form templates have been established. Pile preparation continues ahead of schedule." (See photo, page 11.) However, good rhythm was maintained only as long as equipment functioned, weather cooperated, and the logistical system kept pace. The realities of the operational environment in Port-au-Prince harbor stretched the capabilities of the 544th Engineer Dive Team, UCT 1, and the crew on the USNS *Grasp*.

With no infrastructure in Haiti, the 544th was left to maintain work timelines with only resources immediately onboard the USNS *Grasp* or what was transported in by the Army or Navy. The lag time for bringing supplies to Haiti stood as one of the most vexing challenges. To reduce bottlenecks, the 569th Engineer Dive Detachment Headquarters and the 6th Transportation Battalion S-4 at Fort Eustis allotted funds for unexpected expenses and tracked maintenance on equipment. The 569th and the 6th also shuttled supplies to Navy ports of debarkation and piggybacked on the Navy's logistics system. UCT 1 controlled the flow of resources through the Navy's tracking process and procurement path that ran from Florida, a shorter transit than from Fort Eustis.

The 544th and UCT 1 required a constant influx of replacement equipment, spare parts, and other materials because of failures and malfunctions in the harsh conditions of Port-au-Prince harbor. No doctrine had been written to outline how to maintain continuous dive operations in this austere environment. For instance, when one hydraulic

drill broke down, its parts were cannibalized to keep another "Frankenstein" drill functioning. The 544th eventually used every hydraulic drill in the dive teams' inventories at Fort Eustis. Other equipment also failed from wear or damage and needed to be replaced. Malfunctions or breakdowns frequently interrupted the entire rehabilitation process. They required stopgap solutions on-site, or delays until new equipment or additional spare parts could be procured from Guantanamo Bay or the continental United States.

One of the stopgap solutions illustrated the flexibility and ingenuity of the 544th, UCT 1, and their support personnel. The hose filling the wooden forms with concrete-aggregate mixture clogged on 15 February—only its second day in use. The dried and caked aggregate in the hose needed to be chipped away by hand, causing an unacceptable single point of failure. Either this chipping would slow progress for hours each day, or procuring a new hose would take several more days, and the clogs might reoccur. Neither option was practical. As a way of reducing the number and severity of clogs, it was decided that no aggregate would be added to the concrete; therefore, the hose did not clog anymore. This solution, according to the NAVFAC engineer, actually strengthened the pour, which stood at 12,000 pounds per square inch for pure cement. The only downside to this solution was the subsequent requirement for more concrete to be ordered. Countless other on-site fixes demonstrated knowledge and expertise of the 544th, UCT 1, the NAVFAC engineers, and the carpenters and mechanics working in the staging area and on the USNS *Grasp*. They fabricated or cannibalized whatever was needed with material on hand until long-term solutions could be realized.

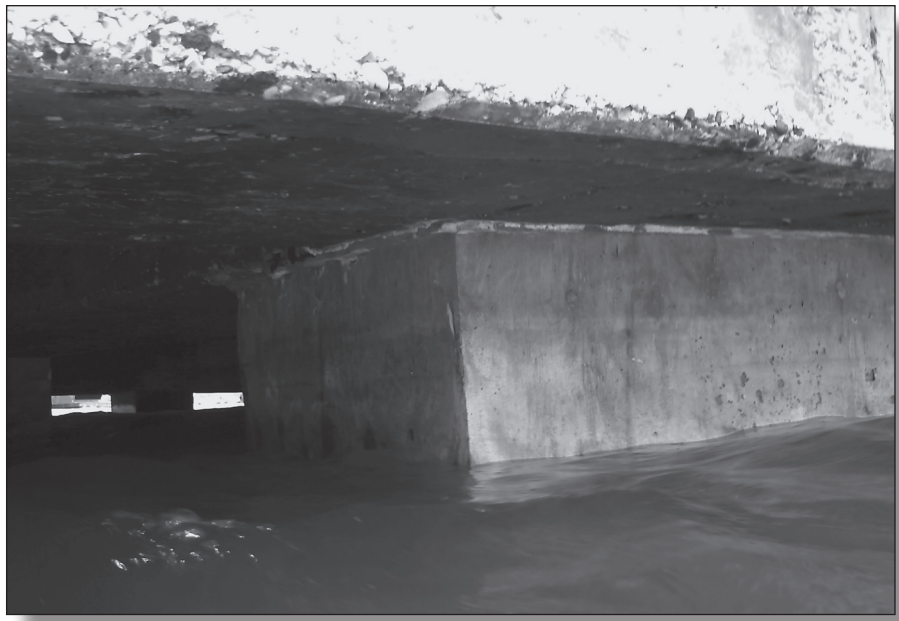
Apart from logistical challenges, numerous environmental problems frequently stalled progress. Every time it rained, the already filthy water became almost impossible to work in because refuse washed off the mainland into the harbor. Waste from tugboats and sewage from the mainland compounded ecological hazards. The only alternative for the Army and Navy divers came in initiating preventive measures—including constantly testing the water's toxicity, monitoring divers' vital statistics, and giving regular doses of antibiotics. No diver with an open wound was allowed in the water. Even with these precautions, one diver developed a rash and was sent to the hospital ship USNS *Comfort* for observation and treatment. Because these hazardous conditions made entering the water daily a mental challenge, the Army and Navy divers should be commended for making their dives without complaints, doing their duty, and completing the mission.

Lessons Learned

Many lessons can be learned from the dive activities in Operation Unified Response. First, equipment breakage or extreme wear slowed the 544th Engineer Dive Team's best efforts to rehabilitate the pier in Port-au-Prince harbor. In the future, Army dive units can avoid or minimize delays by maintaining severe redundancy of equipment and spare parts on the construction sites. In fact, having three or four extra pieces of "no-fail" equipment—the drills and the concrete-pumping equipment, in the case of Haiti—could be particularly critical to reducing lag times in waiting for fabrication, repair, or procurement.

Second, whereas dive-qualified Navy corpsmen served in MDSU 2 and UCT 1, the 544th's Army medic had neither completed the diving course at the Naval Diving Salvage and Training Center nor received certification as a dive medical technician (DMT). While competent in treatment techniques for land operations, that Army medic was not prepared for injuries or complications dealing with respiration or decompression that are unique to underwater operations. In these cases, the 544th needed to rely on the Navy's medical assets. The Soldiers in the 544th thus realized that an Army dive team should add a qualified DMT to its table of organization and equipment (TOE). This would make specialized medical treatment intrinsic to an Army dive team and thereby increase the autonomous functionality of the team.

Third, the experiences in Haiti taught the Soldiers in the 544th that no Army or Navy dive unit can do everything independently in such a complicated operation. To improve effectiveness, joint training exercises between Army divers at Fort Eustis and Navy divers at Norfolk, Virginia, should extend long after Dive School and entail as



U.S. Navy photo

Using a prefabricated wooden form, divers constructed pile caps to reinforce the connection between the piles and the pier.

wide a spectrum of operational scenarios as possible. Merchant Mariners should participate in these joint training exercises to facilitate better communication and coordination between divers and their shipboard support. Likewise, bureaucratic snags—such as the Navy divers not being authorized to use the Army's Extreme Light Dive System—should be resolved in home ports by thoroughly cross-training and completely cross-certifying divers. Consequently, each Service's divers would become more familiar with the other divers' capabilities, equipment, and command structures. These actions would pay dividends in the future when natural disasters occur or humanitarian operations are undertaken. Joint dive operations would never again need to start at the zero-square as they did in Haiti. Increasing joint training exercises is not a recommendation offered only by the authors of this article; one Navy officer from MDSU 2 expressed the same desire to start scheduling Army–Navy dive exercises.

Fourth, rehabilitating the pier in Haiti pointed to the significance of one of the Army divers' key missions. Personnel need to be able to execute port opening and harbor clearance. It matters little if their deployment is in a combat operation or a humanitarian operation; either way, Army divers must be able to give commanders accurate surveys of what is beneath the water's surface and make timely repairs to underwater structures. By maintaining proficiency in these mission-essential tasks, divers help assure mobility and enhance sustainment.

Last, from a rear-detachment commander's perspective, communication and coordination posed the greatest challenges. Communication was extremely difficult at times and was best achieved via e-mail. However, using e-mail created as much as a full day of lag time in sending and receiving messages. Coordinating shipment of goods to earthquake-ravaged Haiti proved no easy task because of the complete lack of logistical infrastructure there. The U.S. military has initiatives in the disaster-response arena that are being designed to pull talent from across the armed services. Ensuring that Army engineer divers are integrated into these initiatives will be a key to success in future disaster-response missions using their diving assets.

Conclusion

Despite many setbacks, the 544th Engineer Dive Team achieved its goal of rehabilitating the south pier in Port-au-Prince harbor and opening it for large vessels offloading great quantities of aid into Haiti. Each of the seventeen divers in the 544th logged at least 350 hours of bottom time over their 10-week deployment in Operation Unified Response. As tangible recognition for their efforts, the Soldiers received two Navy Commendation Medals, four Navy Achievement Medals, five Army Commendation Medals, and six Army Achievement Medals. Each member likewise received the Humanitarian Service Medal as part of Operation Unified Response.

Captain Sann commanded the 544th Engineer Dive Team from December 2009 until its return from Haiti in April 2010. He has completed the Marine Engineer Dive Officer Course, the Sapper Leader Course, Airborne School, Air Assault School, and the Engineer Captains Career course. He holds a bachelor's in integrative biology from the University of California in Berkeley.

Captain Hallman is the commanding officer of the 569th and 74th Engineer Dive Detachments at Joint Base Langley-Eustis, Virginia. He has completed the Primary Leadership Development Course, the Basic Noncommissioned Officer Course, Engineer Officer Basic Course, Engineer Captains Career Course, Czech and Slovak Basic Courses at the Defense Language Institute, Basic Diving Officer Course, Salvage Diver Course, Construction Demolition Diver Course, Instructor Training Course, and the Systems Approach to Training Course. He holds a bachelor's in business administration from Old Dominion University in Norfolk, Virginia, and a master's in geological engineering from the Missouri University of Science and Technology in Rolla, Missouri.

Dr. Ulbrich is a historian at the United States Army Engineer School (USAES), Fort Leonard Wood, Missouri. He received his doctorate in history at Temple University. Before assuming his duties at the Engineer School in 2009, Dr. Ulbrich served as codirector of the Cantigny First Division Oral History Project, which is Web-streamed by Ohio University at <http://media.library.ohiou.edu/cantigny/>.

Sources

544th Engineer Dive Team SITREPs, 15 January-30 March 2010, Operation Unified Response, USAES History Office.

Captain Scott Sann, Oral History Interview with David J. Ulbrich, 30 July 2010, USAES History Office.

First Lieutenant Tim O'Hara, "544th Engineer Dive Detachment," *Bottom Times: MOS 21D Newsletter*, June 2010: 10-11.

Field Manual 3-34.280, *Engineer Diving Operations*, 20 December 2004.

Joe Gould, "Army Divers Work to Fix Haitian Ports," *Army Times*, 2 March 2010, *<http://www.armytimes.com/news/2010/03/army_divers_030110w/>*, accessed 10 September 2010.

Joint Publication 4-01.6, *Joint Logistics Over-the-Shore (JLOTS)*, 5 August 2005.

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